pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Commonwealth of Pennsylvania
Department of Environmental Protection
Ozone Exceptional Event Analysis
May 24-26, 2016

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Commonwealth of Pennsylvania

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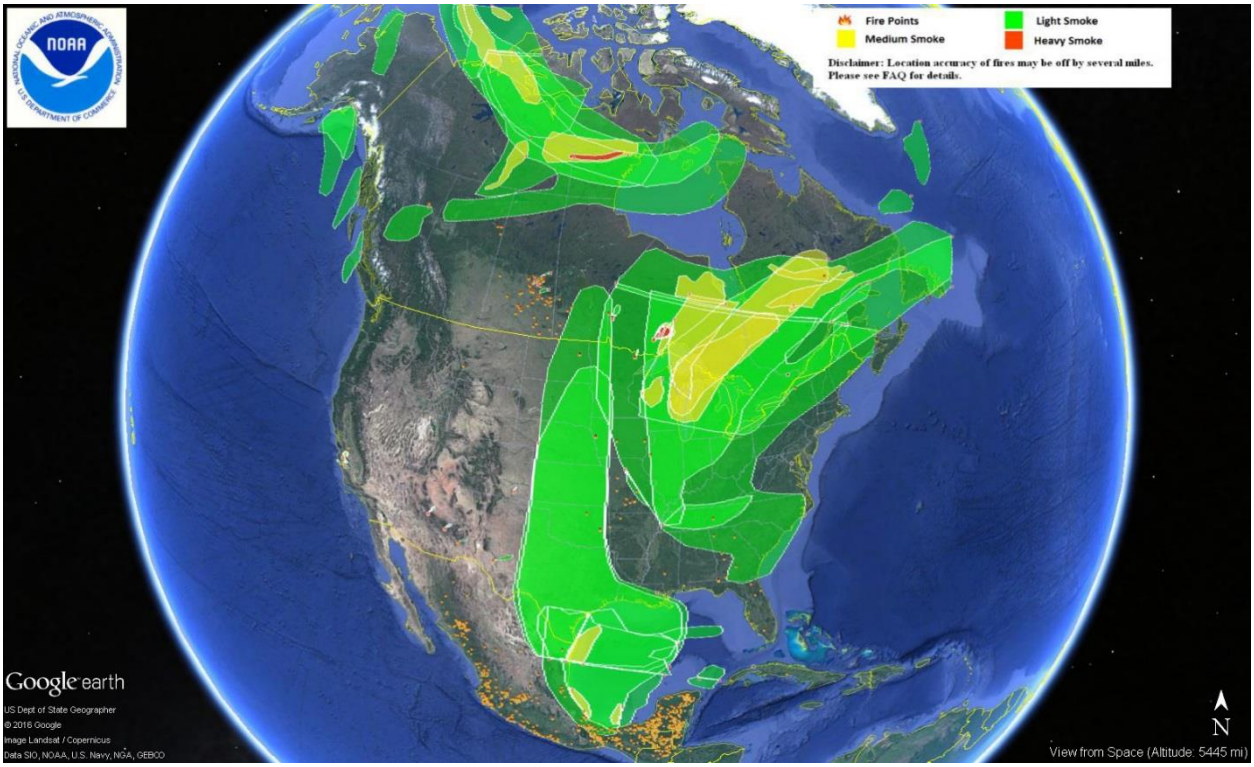
Introduction

On May 24, 2016, Pennsylvania began to feel the effects of elevated ozone concentrations originating from the upper Midwest. This event lasted across Pennsylvania until May 26, 2016, impacting various ozone monitors as the air mass traveled from west to east across the Commonwealth.

After further analysis, the trajectory from which this ozone episode arrived across the Commonwealth was very unusual. After analyzing meteorological and photochemical processes across North America during this three-day period, it became very evident that an air mass from northwestern Canada (specifically from Fort McMurray, Alberta, Canada) had moved in across the northeastern US and impacted air quality from areas as far west as Wisconsin to as far east as Massachusetts. Figure 1 below displays the NOAA HMS analysis of fire and smoke locations across North America on May 22, 2016.

Figure 1 – NOAA HMS Analysis of Fire and Smoke Locations on May 22, 2016



As required by the Exceptional Events Rule (40 CFR Part 50.14), the Department sent an email to EPA Region 3 on January 19, 2017 addressing the Department's intent to submit an exceptional events analysis, excluding ozone data from May 25, 2016 and May 26, 2016. After further evaluation, the Department is proposing to include May 24, 2016 as part of this exceptional event analysis. In the email, the Department discussed such factors as the extent of smoke across North America while discussing back trajectories from areas of Pennsylvania that were impacted from the smoke. The Department also included an analysis of how this event impacted design value calculations at every ozone monitor in Pennsylvania.

Within this document, the Department will discuss the feasibility of excluding the May 24, May 25, and May 26, 2016 ozone data from a select group of monitors operated by the Department and the Philadelphia Air Management Services. This discussion will include an analysis of air quality data, including ozone and PM2.5 speciation data, and meteorological data.

EPA Exceptional Event Guidance Overview

In October 2016, EPA released a revised Exceptional Event Rule (codified in 40 CFR Part 50.14). 40 CFR Part 50.14.b discusses the determinations that the EPA Regional Administrator can make on excluding data, including the following:

1.) Generally
2.) Fireworks displays
3.) Prescribed fires
4.) Wildfires
5.) High wind dust events
6.) Stratospheric intrusions
7.) Determinations with respect to event aggregation, multiple national ambient air quality standards for the same pollutant, and exclusion for 24-hour values for particulate matter
8.) Determinations with respect to the not reasonably controllable or preventable criterion.
9.) Mitigation plans.

This exceptional event analysis would be classified as being influenced by wildfires. Furthermore, the wildfire section goes on to state the following:

"The Administrator shall exclude data from use in determinations of exceedances and violations where a State demonstrates to the Administrator's satisfaction that emissions from wildfires caused a specific air pollution concentration in excess of one or more national ambient air quality standard at a particular air quality monitoring location and otherwise satisfies the requirements of this section. Provided the Administrator determines that there is no compelling evidence to the contrary in the record, the Administrator will determine every wildfire occurring predominantly on wildland to have met the requirements identified in paragraph (c)(3)(iv)(D) of this section regarding the not reasonably controllable or preventable criterion."

The Department intends to follow the guidance outlined within the Exceptional Event Rule to properly assess the impact of the Fort McMurray wildfires on ozone concentrations across the Commonwealth.

Regulatory Significance

When the Exceptional Event Rule was released, EPA also announced dates by which state/local organizations had to submit their exceptional event analyses. For 2016 ozone data that was being used for consideration in EPA's 2015 ozone NAAQS nonattainment designations, the deadline for submittal was May 31, 2017. As a result, the Department completed an analysis of ozone monitors within the Commonwealth that were impacted from May 24 to May 26. Table 1

below displays the monitors that the Department feels an exceptional event exclusion could have on regulatory significance today as it relates to the designation process for the 2015 ozone standard. In addition, Table 1 below illustrates the impact that the May 25 and May 26 daily maximum 8-hour ozone concentrations on had on the current 2016 ozone design values for these respective monitors. The Department has already flagged this data in EPA's Air Quality System database for possible exceptional event exclusion.

Table 1 – Pennsylvania Monitors Requested for Exceptional Event Exclusion

AQS Code	Site Name	4th Max 2014 (ppb)	4th Max 2015 (ppb)	4th Max 2016 (ppb)	4th Max 2016, excluding May exceptional events** (ppb)	2014-2016 Design Value (ppb)	2014-2016 Design Value, excluding May exceptional events** (ppb)
420110011	Reading Airport	68	71	75	71	**71**	**70**
420170012	Bristol	71	82	80	75	**77**	**76**
420290100	New Garden	71	68	80	75	**73**	**71**
420750100	Lebanon	67	74	72	70	**71**	**70**
420910013	Norristown	72	73	73	67	**72**	**70**
421010024	Northeast Airport	72	79	80	78	**77**	**76**
421010048	Northeast Waste	68	78	76	75	**74**	**73**

** May exceptional event period is May 25 to May 26

The Department is also requesting that EPA consider the ozone monitors highlighted in Table 2 for exceptional event exclusion. Although the monitors outlined in Table 2 do not have regulatory significance as it relates to the designations for the 2015 ozone standard, the Department is concerned with the impact that the Fort McMurray wildfires could potentially have on these monitors as it relates to future year design value calculations for 2017 and 2018.

Table 2 – Additional Pennsylvania Monitors Requested for Exceptional Event Exclusion

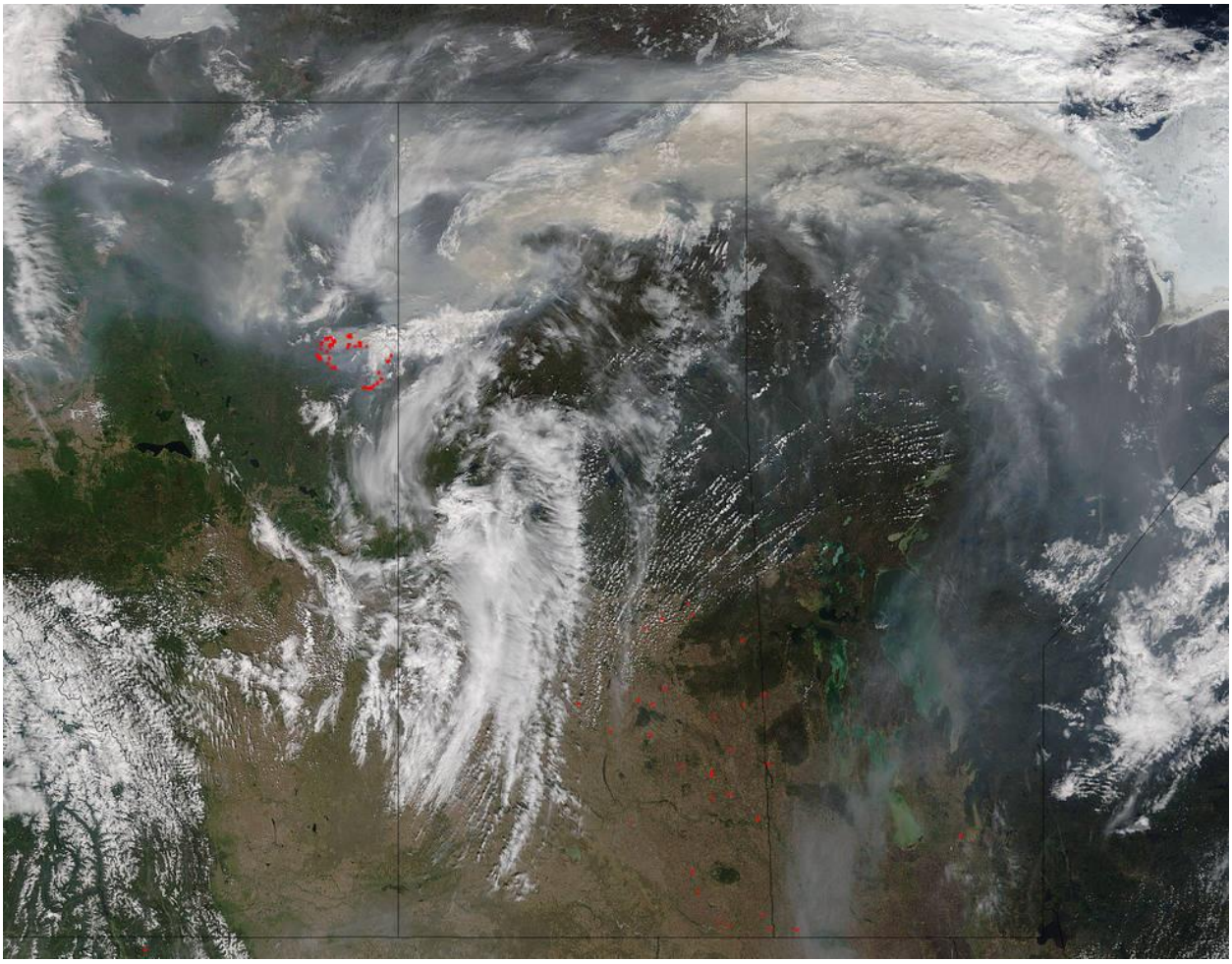
AQS Code	Site Name	4th Max 2014 (ppb)	4th Max 2015 (ppb)	4th Max 2016 (ppb)	4th Max 2016, excluding May exceptional events** (ppb)	2014-2016 Design Value (ppb)	2014-2016 Design Value, excluding May exceptional events** (ppb)
420010001	Arendtsville		65	73	72	**N/A**	**N/A**
420050001	Kittanning	68	70	73	71	**70**	**69**
420070002	Hookstown	69	70	71	69	**70**	**69**
420110006	Kutztown	63	66	70	68	**66**	**65**
420430401	Harrisburg	63	68	68	64	**66**	**65**
420431100	Hershey	63	68	70	67	**67**	**66**
420490003	Erie	65	66	67	66	**66**	**65**
420630004	Strongstown	68	73	71	68	**70**	**69**
420690101	Peckville	61	69	71	68	**67**	**66**
420710007	Lancaster	66	71	71	66	**69**	**67**
420710012	Lancaster Downwind	63	70	67	62	**66**	**65**
420770004	Allentown	68	70	73	71	**70**	**69**
420810100	Montoursville	62	65	65	63	**64**	**63**
420950025	Freemansburg	67	70	75	72	**70**	**69**
420958000	Easton	66	67	74	69	**69**	**67**
421010004	Ams Laboratory	58	57	69	67	**61**	**60**
421174000	Tioga County	58	65	68	64	**63**	**62**
421255001	Florence	64	71	70	68	**68**	**67**
421330011	York Downwind	63	74	73	69	**70**	**68**

** May exceptional event period is May 25 to May 26

Fort McMurray Fire Discussion

During the entire month of May 2016 and June 2016, the wildfires that burned in and around Fort McMurray, Alberta, Canada encompassed upwards of 1,500,000 acres of land. As provided by NASA, Figure 2 below displays MODIS satellite imagery from May 17, 2016 across southwestern Canada. Specifically, the MODIS imagery emphasizes the location of the Fort McMurray fires with respect to cloud cover and smoke plume extent. The Fort McMurray fires, highlighted in red below, were analyzed by MODIS's thermal bands.

Figure 2 – NASA MODIS Imagery of the Fort McMurray Fires on May 17, 2016



Source: https://www.nasa.gov/feature/goddard/2016/nasa-satellites-image-fort-mcmurray-fires-day-and-night

The Fort McMurray fires were covered by various news agencies across the world. On May 6, 2016, an article in the Washington Post highlighted that smoke from the Fort McMurray fires had infiltrated the southeastern US. The article goes on to state that the smoke traveled down to the Gulf Coast due to meteorological factors such as upper level winds transporting the smoke southward. Later in May, a Weather Channel article discussed the impact that Fort McMurray wildfires were having on Europe. Using NASA's Aerosol Index as a tool, the Weather Channel was able to watch the transport of smoke (aerosols) from western Canada eastward across the northern Atlantic and into western Europe. As the Weather Network noted in an article on June 14, 2016, Canadian wildfire investigators ruled out lightning as the probable cause of the start of the wildfire, thus establishing that the event was likely the result of human activity.

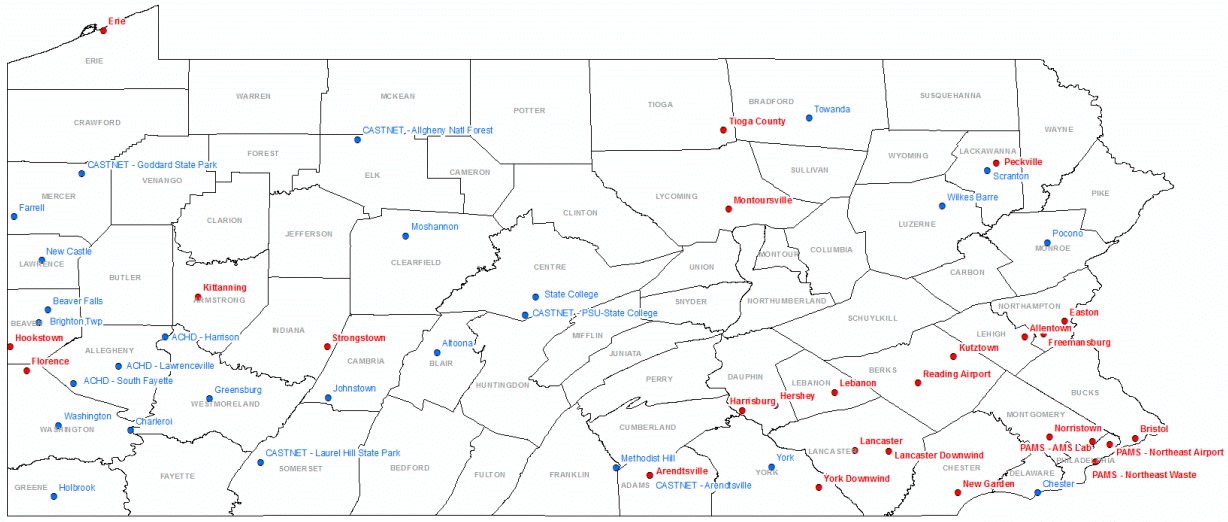
By July 6, 2016, the fire was declared to be under control. It was estimated that 2,400 building were destroyed because of the fire. In addition, direct and indirect costs associated with the fire were estimated to be in the $9.5 billion range.

Monitoring Data Analysis

Within the Commonwealth, four federal/state/local agencies operate 53 ozone monitors. The Department currently operates 42 of the ozone monitors in 65 of the 67 counties. EPA currently operates five ozone monitors under the CASTNET program. Local agencies Allegheny County Health Department (ACHD) and Philadelphia Air Management Services (PAMS) each operate three ozone monitors.

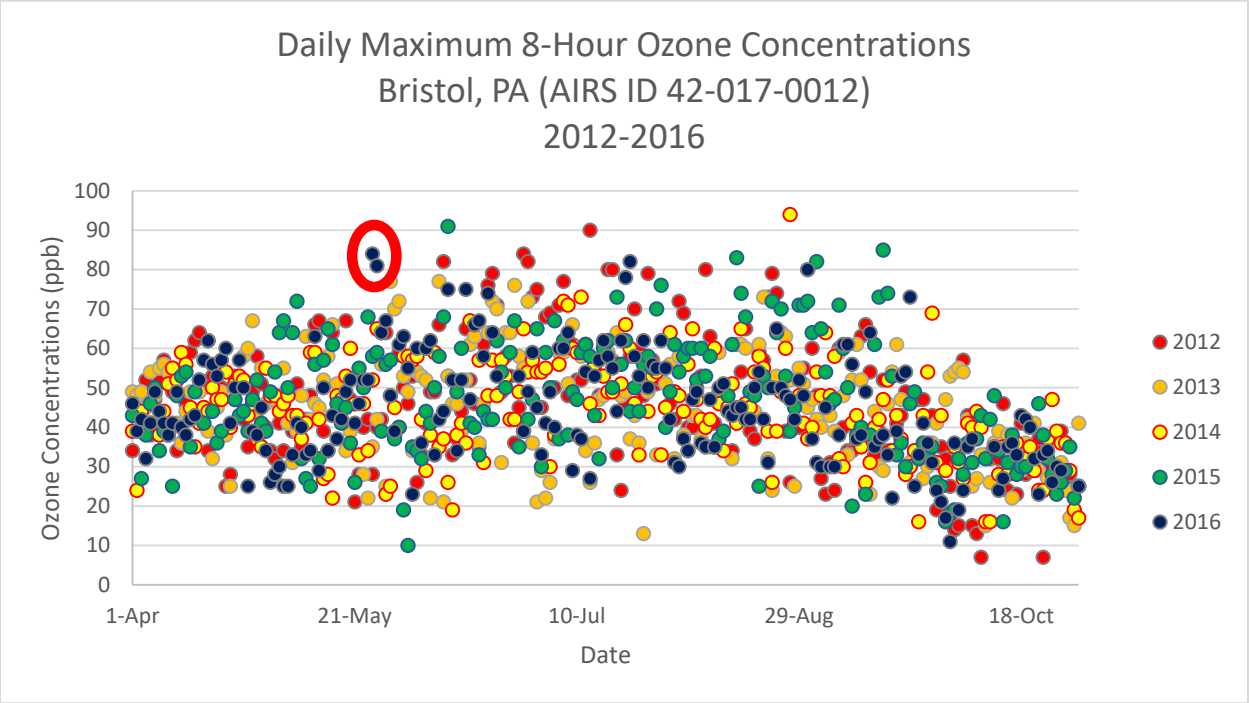
The Department monitors ozone year-round. Figure 3 displays a map of all 53 ozone monitors outlined above. Ozone monitors selected for additional analysis as it relates to exceptional event exclusion are highlighted in red.

Figure 3 – Pennsylvania Ozone Monitoring Network



At every monitored listed in red above, an analysis was completed to determine the trend of ozone concentrations over the 2012 to 2016 period. As an example, Bristol is highlighted below in Figure 4.

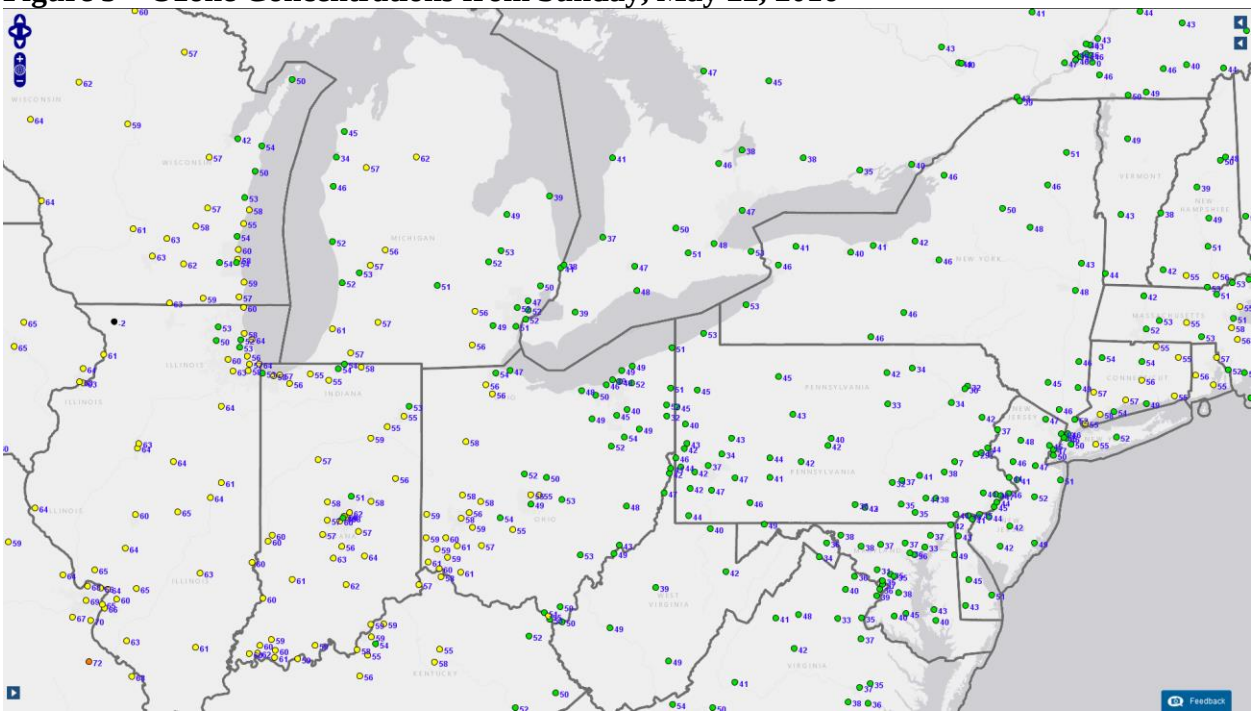
Figure 4 – Bristol, PA Daily Ozone Season Maximums 2012-2016



As illustrated in the red circle above, the May 25 and May 26 daily maximum 8-hour ozone concentrations at Bristol were the highest 8-hour ozone concentrations monitored at Bristol during any May date from 2012 to 2016. As a result, there must have been something exceptional contributing to the two exceedances of the 2015 ozone standard.

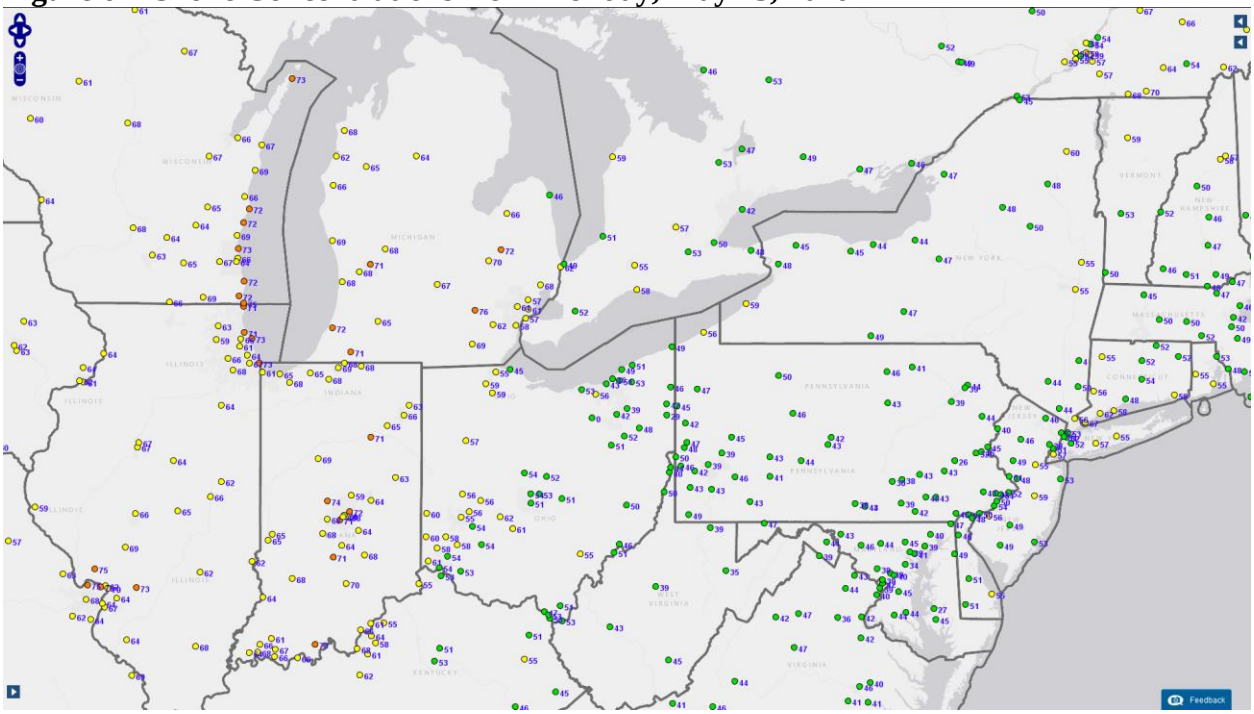
The following figures (Figure 5 through Figure 11) display daily maximum 8-hour ozone concentrations, respectively, from May 22, 2016 to May 28, 2016 from the upper Midwest eastward into Massachusetts.

Figure 5 – Ozone Concentrations from Sunday, May 22, 2016



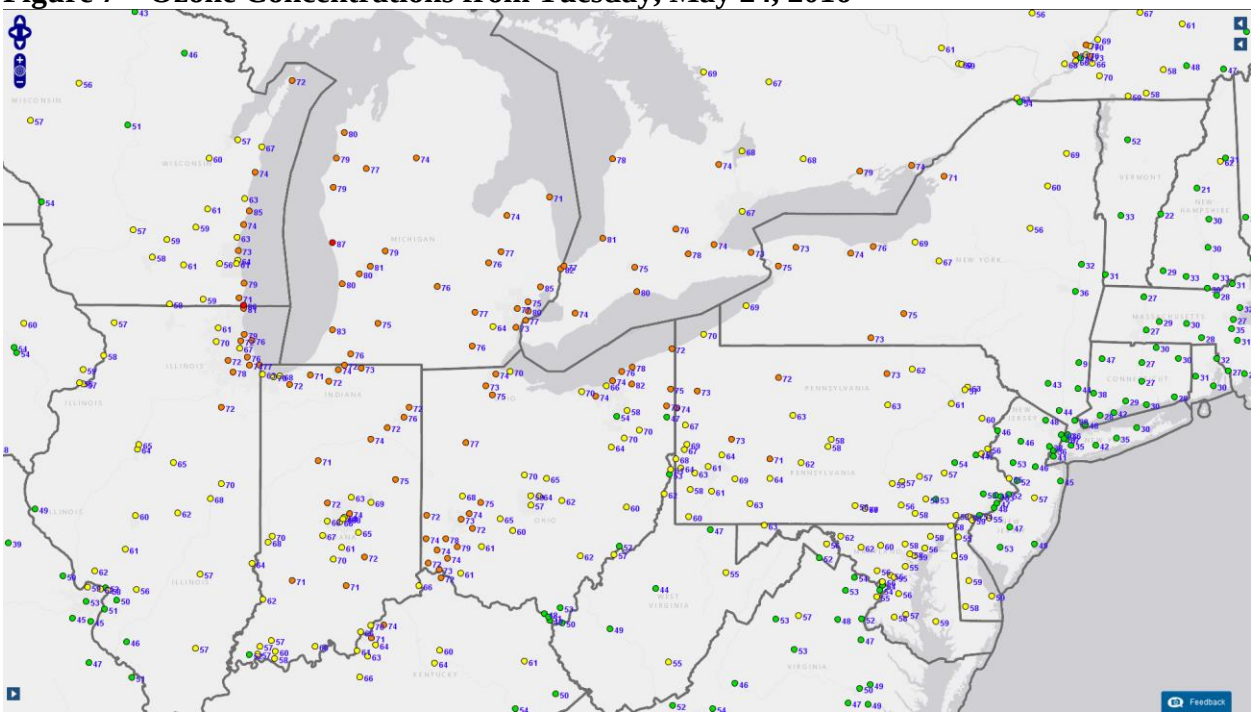
Source: http://www.airnowtech.org

Figure 6 – Ozone Concentrations from Monday, May 23, 2016



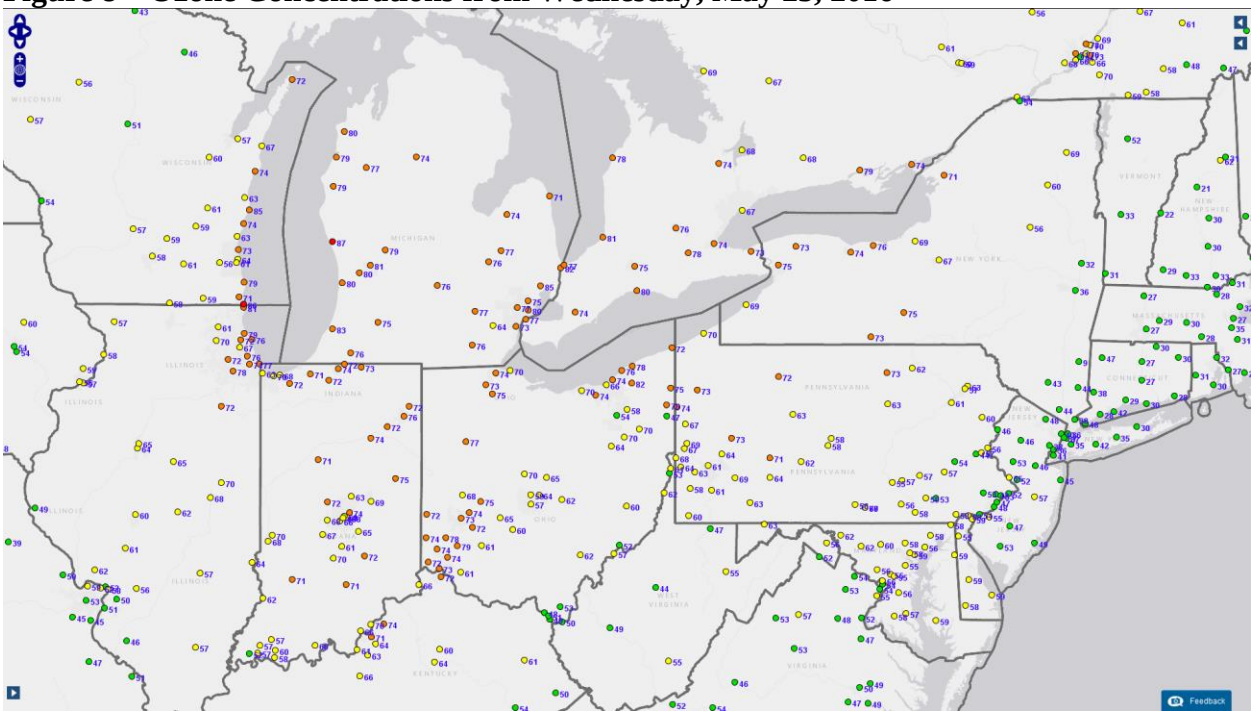
Source: http://www.airnowtech.org

Figure 7 – Ozone Concentrations from Tuesday, May 24, 2016



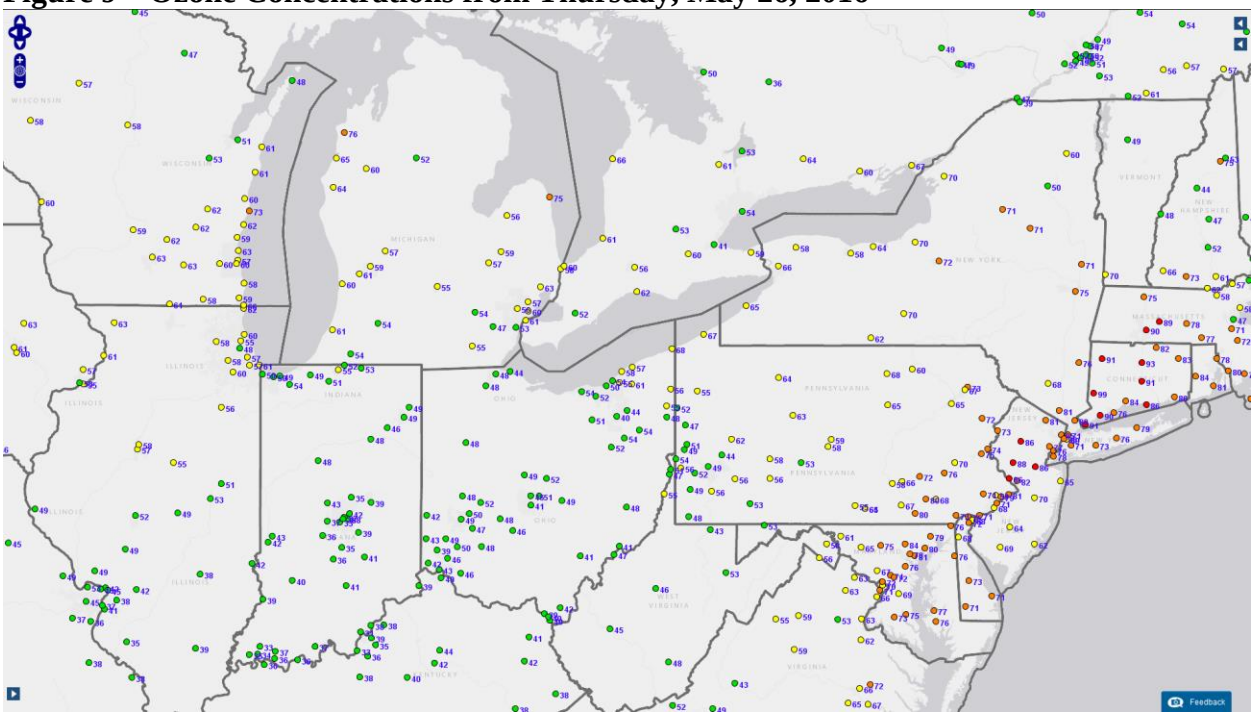
Source: http://www.airnowtech.org

Figure 8 – Ozone Concentrations from Wednesday, May 25, 2016



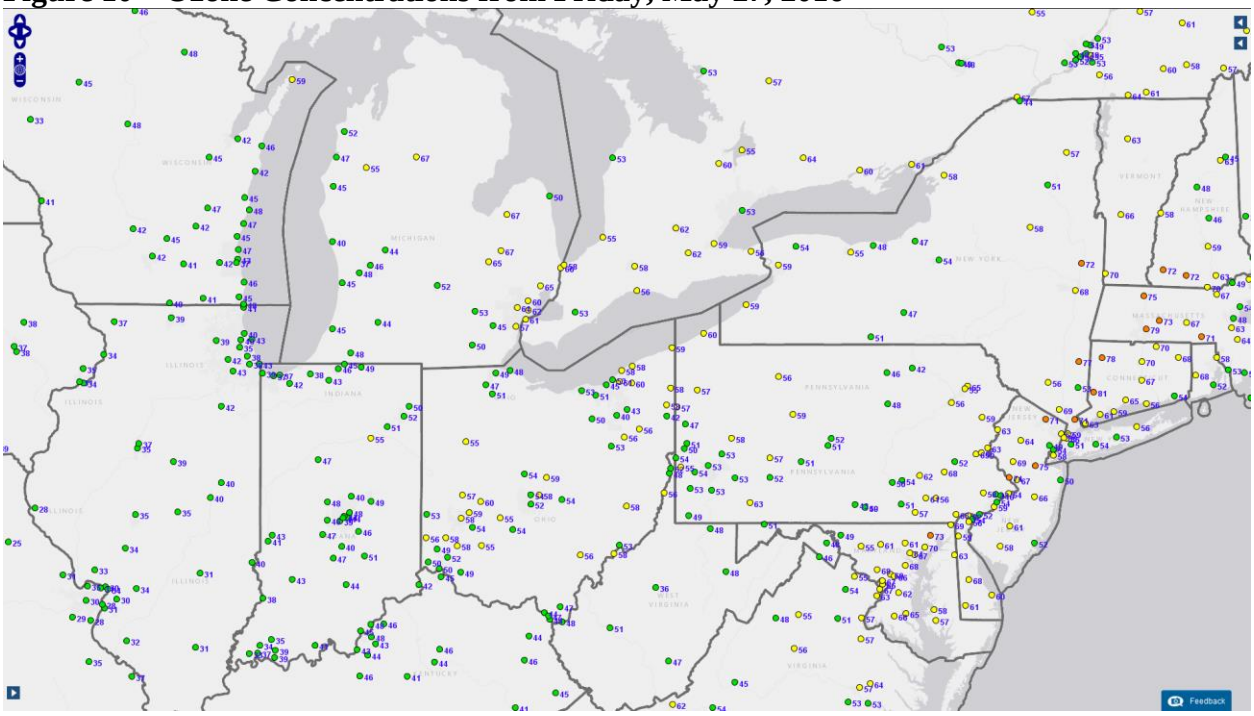
Source: http://www.airnowtech.org

Figure 9 – Ozone Concentrations from Thursday, May 26, 2016



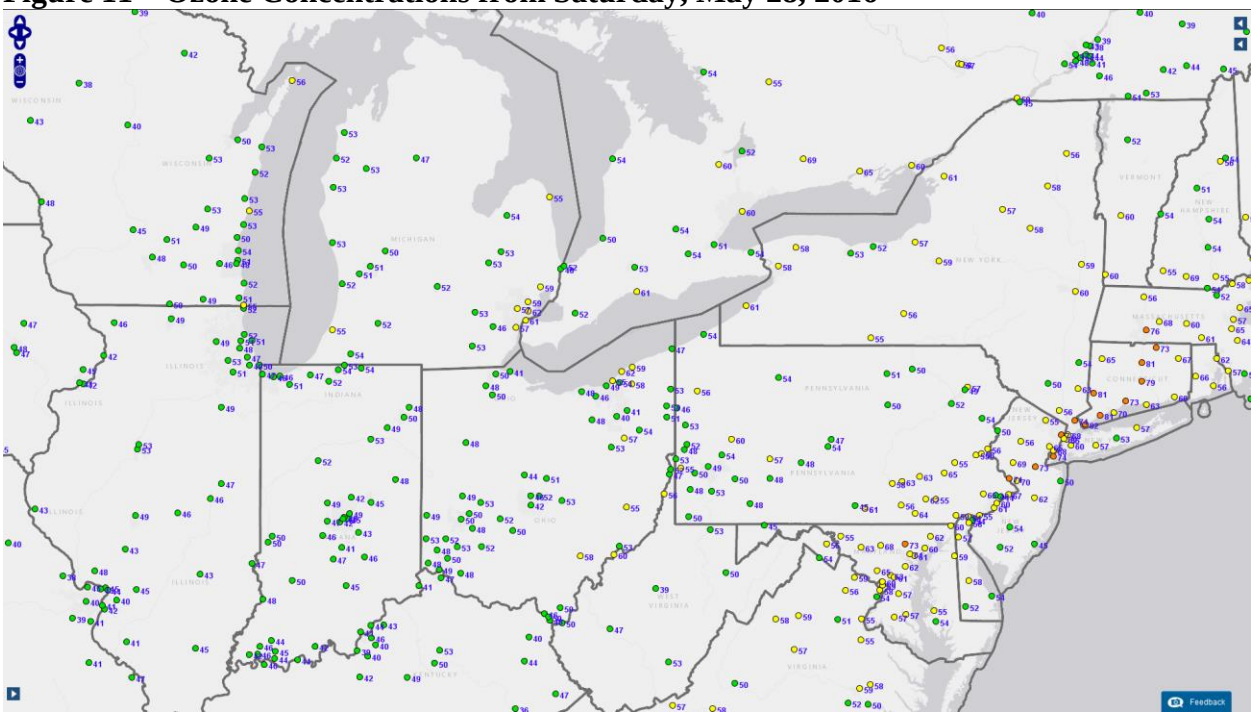
Source: http://www.airnowtech.org

Figure 10 – Ozone Concentrations from Friday, May 27, 2016



Source: http://www.airnowtech.org

Figure 11 – Ozone Concentrations from Saturday, May 28, 2016



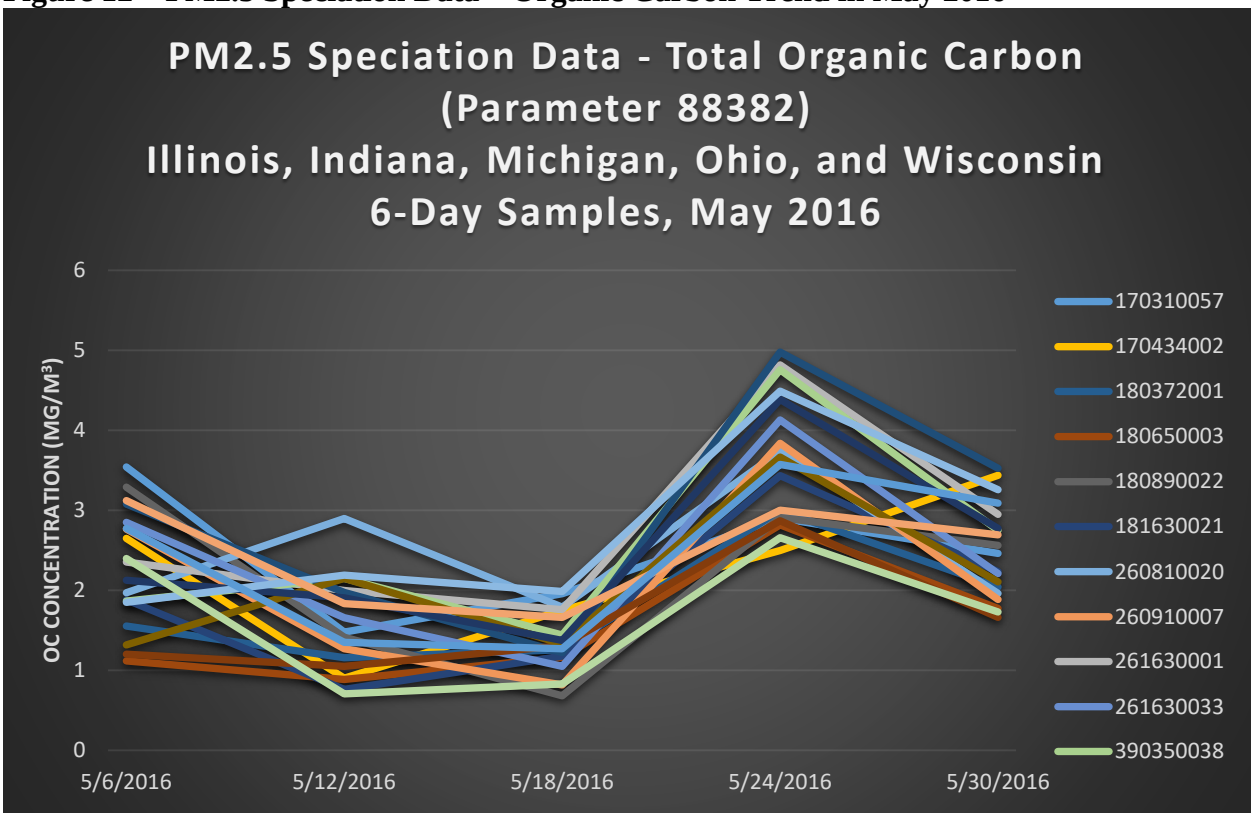
Source: http://www.airnowtech.org

The seven figures above illustrate the progression of the higher ozone concentrations from west to east across the Great Lakes region and into the northeastern US.

In addition to analyzing ozone concentrations, the Department analyzed PM2.5 speciation concentrations. Various states across the US operate PM2.5 speciation monitors to assess what constituents of PM2.5 contribute to PM2.5 formation on any given day. Most PM2.5 speciation monitors operate on a 1 in 6 day schedule. In May 2016, there were five days in which PM2.5 monitors ran: May 6, May 12, May 18, May 24, and May 30. Since much of the impact with regards to high ozone concentrations across Pennsylvania occurred on May 25 and May 26, the Department analyzed PM2.5 speciation data from monitors operating on May 24 in five states, including Illinois, Indiana, Michigan, Ohio and Wisconsin.

With respect to the PM2.5 speciation data in the five states listed above, the Department analyzed organic carbon. Wildfires produce a lot of volatile organic compounds (VOCs) and nitrogen oxides (NOx). Therefore, elevated levels of organic carbon are a good indicator of whether an air mass filled with smoke is reaching the ground. Figure 12 displays the trend of organic carbon at various PM2.5 speciation monitors across five states.

Figure 12 – PM2.5 Speciation Data – Organic Carbon Trend in May 2016



Meteorological Data Analysis

The meteorology on May 24 to May 26, 2016 played a crucial role in the transport of smoke from the Fort McMurray wildfires southeast across Canada and into the northeastern US. A reanalysis of the meteorological conditions that occurred on May 24 to May 26, 2016 was completed by Weatherbell Analytics, Inc. Figures 13 to 15 displays the meteorological conditions that were present on May 24 to May 26 at 250 mb (250 mb is indicative of the jet stream location. The jet stream drives the weather patterns, in this case smoke, from western Canada into the northeastern US).

Figure 13 – 250 mb wind pattern on May 24, 2016 at 8 AM

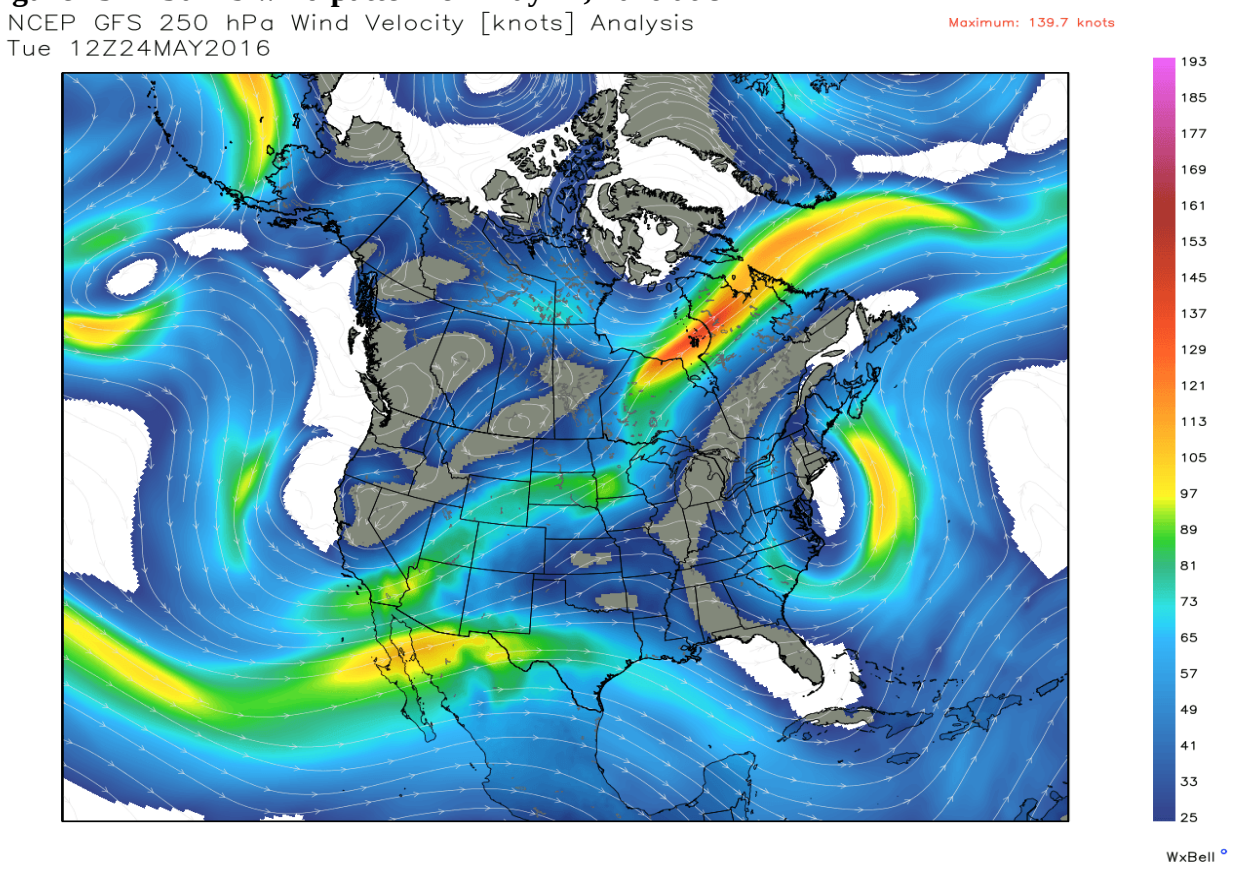


Figure 14 – 250 mb wind pattern on May 25, 2016 at 8 AM

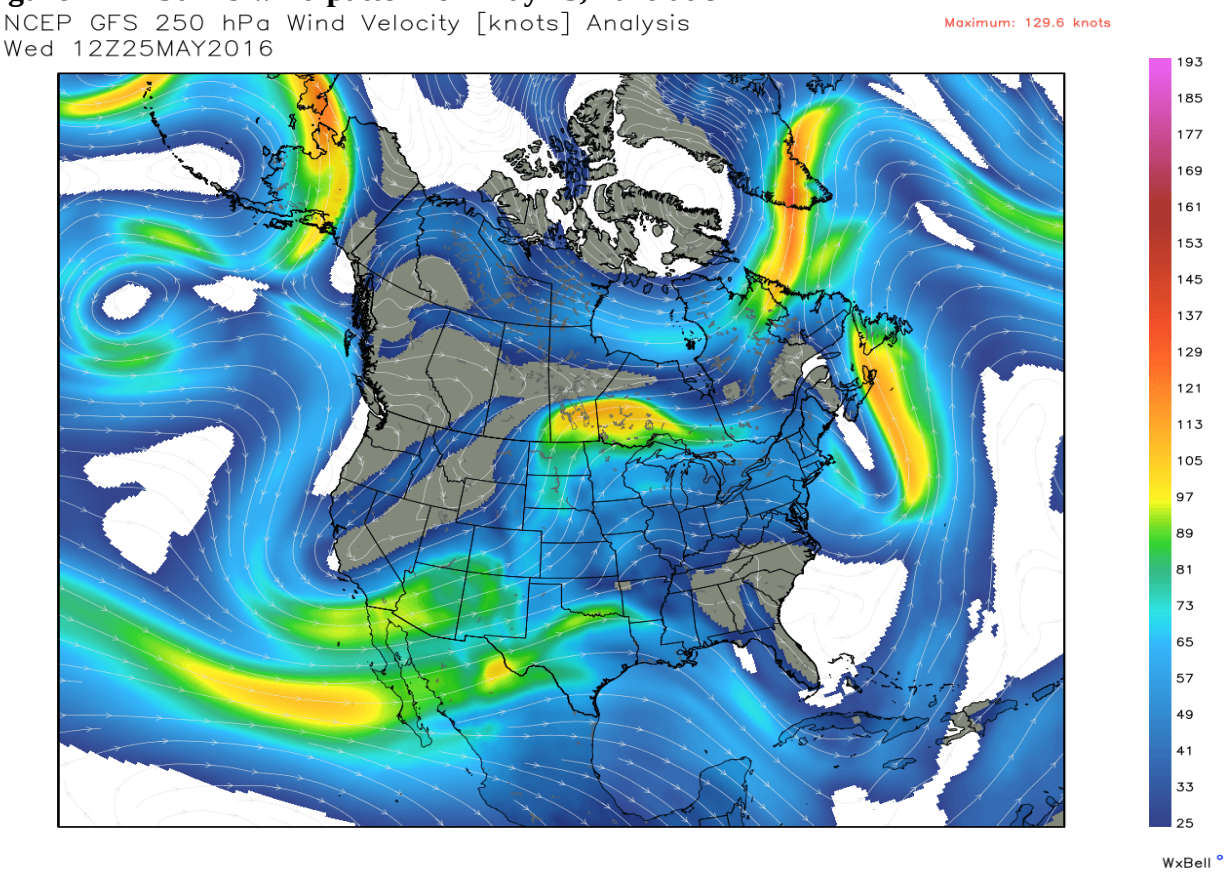
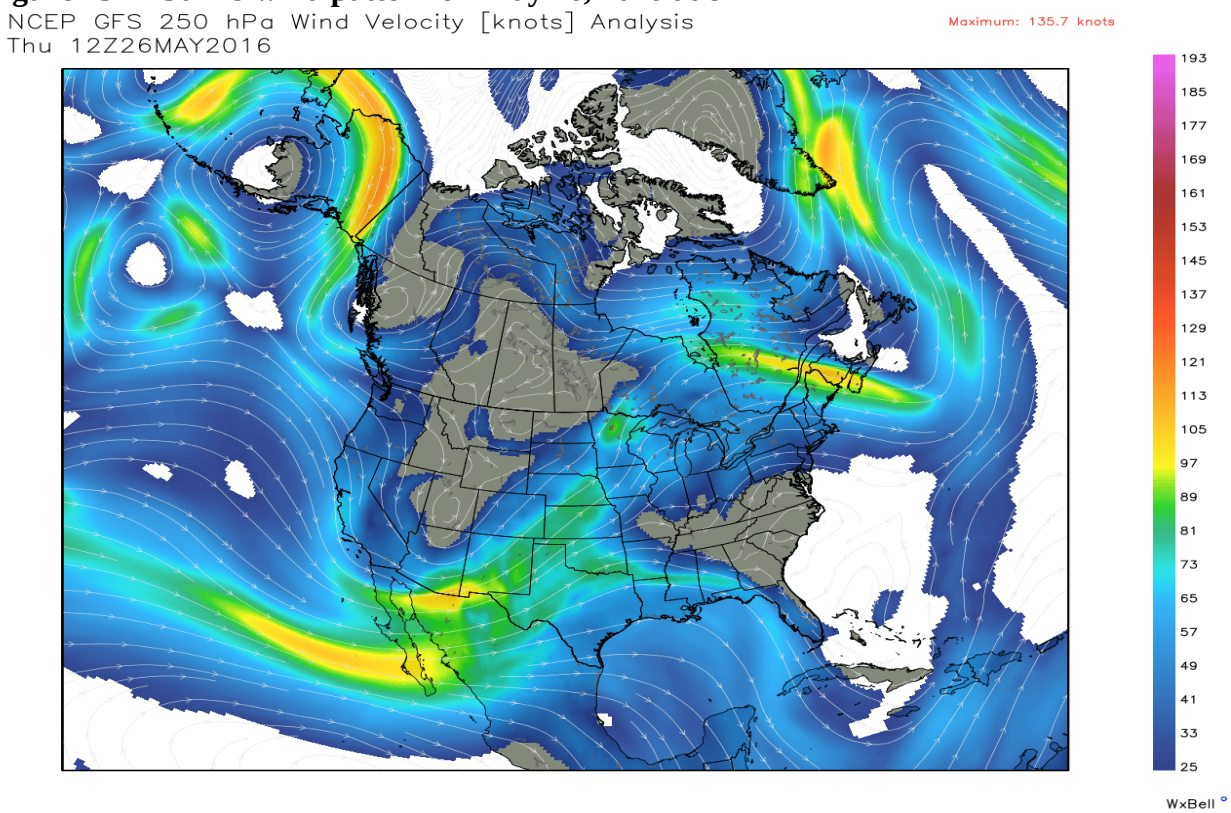


Figure 15 – 250 mb wind pattern on May 26, 2016 at 8 AM



As demonstrated in the three previous figures, the upper level winds, which steer the weather patterns across the world, were conducive to funneling smoke in from western Canada.

Conclusions

In conclusion, based on the Department's in-depth analysis into the contributions of high ozone across the Commonwealth on May 24 to May 26, 2016, the Department feels that transport of smoke associated with the Fort McMurray fires in Alberta, Canada, contributed to the elevated readings. Therefore, the Department (along with PAMS) is requesting that the May 24 to May 26, 2016 ozone concentrations be excluded from the monitors previously mentioned due to the guidelines set forth within the October 2016 revised Exceptional Event Rule.